# Energy Tips – Process Heating

Process Heating Tip Sheet #1 • November 2007

Industrial Technologies Program

## Preheated Combustion Air

For fuel-fired industrial heating processes, one of the most potent ways to improve efficiency and productivity is to preheat the combustion air going to the burners. The source of this heat energy is the exhaust gas stream, which leaves the process at elevated temperatures. A heat exchanger, placed in the exhaust stack or ductwork, can extract a large portion of the thermal energy in the flue gases and transfer it to the incoming combustion air. Recycling heat this way will reduce the amount of the purchased fuel needed by the furnace.

Many processes produce dirty or corrosive exhaust gases that will plug or attack heat exchangers. Some exchangers are more resistant to these conditions than others, so if your process is not a clean one, do not give up without investigating all the options. When discussing it with potential vendors, be sure to have a detailed analysis of the troublesome materials in your exhaust gas stream.

Fuel savings for different furnace exhaust gas temperature and preheated combustion air temperatures can be found in the table below and can be used to estimate reductions in energy costs.

**Percent Fuel Savings Gained from Using Preheated Combustion Air**

| Furnace Exhaust Temperature, ˚F | Preheated Air Temperature, ˚F | | | | | |
|---|---|---|---|---|---|---|
| | 600 | 800 | 1,000 | 1,200 | 1,400 | 1,600 |
| 1,000 | 13 | 18 | — | — | — | — |
| 1,200 | 14 | 19 | 23 | — | — | — |
| 1,400 | 15 | 20 | 24 | 28 | — | — |
| 1,600 | 17 | 22 | 26 | 30 | 34 | — |
| 1,800 | 18 | 24 | 28 | 33 | 37 | 40 |
| 2,000 | 20 | 26 | 31 | 35 | 39 | 43 |
| 2,200 | 23 | 29 | 34 | 39 | 43 | 47 |
| 2,400 | 26 | 32 | 38 | 43 | 47 | 51 |

Fuel: Natural gas at 10% excess air: Source: IHEA Combustion Technology Manual (see Resources)

There are two types of air preheaters: recuperators and regenerators. Recuperators are gas-to-gas heat exchangers placed on the furnace stack. Internal tubes or plates transfer heat from the outgoing exhaust gas to the incoming combustion air while keeping the two streams from mixing. Recuperators are available in a wide variety of styles, flow capacities, and temperature ranges. Regenerators include two or more separate heat storage sections, each referred to as a regenerator. Flue gases and combustion air take turns flowing through each regenerator, alternately heating the storage medium and then withdrawing heat from it. For uninterrupted operation, at least two regenerators and their associated burners are required: one regenerator is needed to fire the furnace while the other is recharging.

**Payback Period = (Cost of combustion air preheating system, obtained from the supplier or contractor) ÷ (Reduction in fuel usage, Million Btu/hr x Number of operating hours per year x Cost of fuel per Million Btu)**

### Payback Guidelines

Process temperature is customarily used as a rough indication of where air preheating will be cost effective. Processes operating above 1,600° F are generally good candidates, while preheated air is difficult to justify on processes operating below 1,000° F. Those in the 1,000˚ to 1,600° F range may still be good candidates but must be evaluated on a case-by-case basis.

These guidelines are not ironclad. Financial justification is based on energy (or Btu) saved, rather than on temperature differential. If a low temperature process has a high enough exhaust gas flow, energy savings may still exist, even though the exhaust gas temperature is lower than 1,000° F.

### Resources

*Combustion Technology Manual.* Published by Industrial Heating Equipment Association (IHEA), Arlington, Virginia 22209.

*Maintenance and Adjustment Manual for Natural Gas and No. 2 Fuel Oil Burners.* Technical Information Center, Department of Energy.

*Handbook of Applied Thermal Design*, edited by Eric C. Guyer. Published by McGraw Hill Book Company.

**U.S. Department of Energy—** For additional information on process heating system efficiency, to obtain DOE's publications and Process Heating Assessment and Survey Tool (PHAST) software, or learn more about training, visit the BestPractices Web site at www.eere.energy.gov/industry/bestpractices.

## Example

A furnace operates at 1600° F for 8,000 hours per year at an average of 10 million British thermal units (MMBtu) per hour using ambient temperature combustion air. At $9 per MMBtu, annual energy cost is $720,000. Use of preheated air at 800° F will result in 22% fuel savings, or $158,400 annually. The preheated air system installation is estimated to cost $200,000 to $250,000, with a simple payback period of 15 to 19 months.

### Suggested Actions

- Using current or projected energy costs, estimate preheated air savings with this example or the Process Heating Assessment and Survey Tool (PHAST) available from the Department of Energy's Industrial Technologies Program.
- Contact furnace or combustion system suppliers to calculate payback period or ROI.

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